

Regional Data Assimilation of AIRS Profiles and Radiances at the SPoRT Center

Brad Zavodsky, Shih-hung Chou, Gary Jedlovec

NASA/MSFC

NASA Sounder Science Team Meeting

Greenbelt, MD

October 14, 2009



transitioning unique NASA data and research technologies to the NWS



- ◆ SPoRT Overview
- ◆ Overview of WRF-Var AIRS Profile Assimilation Set-Up
- ◆ Results
- ◆ Explanation of Results/Lessons Learned
- ◆ Conclusions



NASA's Short Term Prediction Research and Transition (SPoRT) Center

Mission: Apply NASA measurement systems and unique Earth science research to improve the accuracy of short-term (0-24 hr) weather prediction at the regional and local scale
(<http://weather.msfc.nasa.gov/sport/>)

- ◆ Test-bed for rapid prototyping of new products
- ◆ Development of new products is end-user driven
- ◆ Transition research capabilities/products to operations
 - real-time MODIS and GOES data and products to NWS weather forecast offices and private companies (e.g. Worldwinds, Inc., The Weather Channel)
- ◆ Development of new products and capabilities for transition
 - MODIS SST composites, AMSR-E rain rates, ocean color products
- ◆ AIRS Data Uses/Plans
 - Regional assimilation of L2 temperature and moisture profiles into regional model (Chou, Zavodsky)
 - Regional assimilation of L1B radiances into regional model (McCarty; paper published in JGR)
 - L2 temperature and moisture profile product
- ◆ All work with AIRS has application to other current (IASI) and future (CrIS) instruments

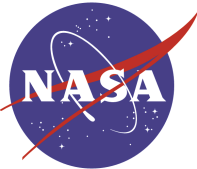


transitioning unique NASA data and research technologies to the NWS



Past Work with WRF-Var

- ◆ Developed and tuned WRF-Var system to assimilate AIRS L2 temperature and moisture profiles for more realistic-looking analyses and forecasts
 - generated background error covariance matrix using control WRF forecasts and internal “gen_be” software (NMC method)
 - altered source code to add AIRS profile data sets as separate land and water sounding data types with separate error characteristics
- ◆ Knowledge gained through these experiments can be applied to other hyperspectral sounder data (e.g. IASI, CrIS, etc.)
- ◆ Have examined over a month of analyses and forecasts
- ◆ We initially found mixed results with forecasts containing AIRS profiles with better results at later forecast hours
- ◆ What follows is an overview of the some lessons learned in data assimilation of AIRS thermodynamic profiles in our



WRF-Var Setup Overview

AIRS QI's for 17 Jan 2007

- ◆ L2 Version 5 temperature and moisture profiles
- ◆ 28-level standard product
- ◆ Land and water soundings w/ separate errors
- ◆ Quality control using P_{best} value in each profile

Current Analysis Error Characteristics

BKGD

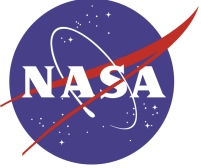
AIRS water

AIRS land

- ◆ WRF initialized with 40-km NAM at 0000 UTC
- ◆ 12-km analysis and model grid
- ◆ Short WRF forecast used as background for analysis



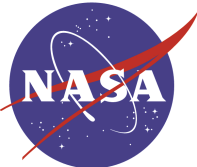
transitioning unique NASA data and research technologies to the NWS



Overview of Results

- ◆ Mixed results
- ◆ show high MSLP fields
- ◆ show mixed temperature results





Cold Bias in WRF Forecasts with Dudhia Scheme

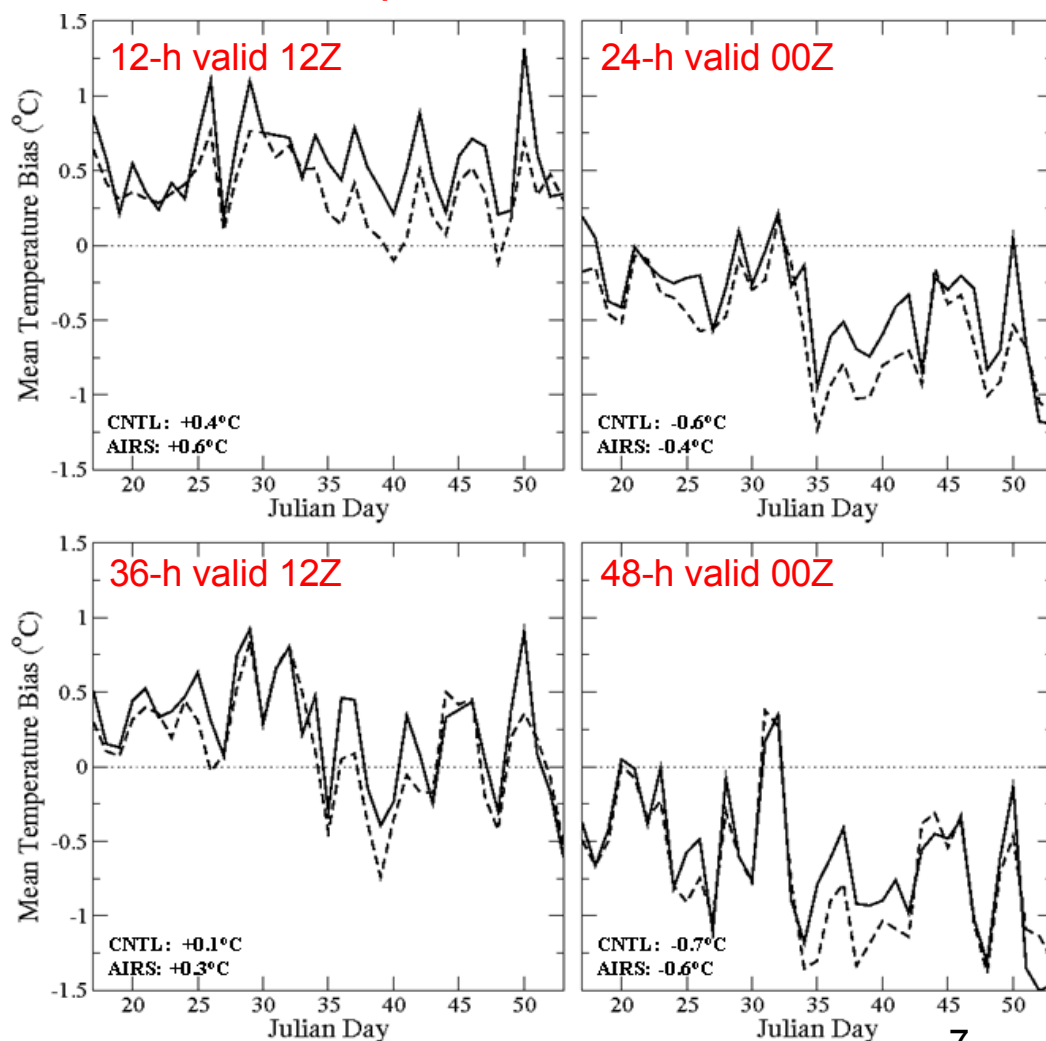
◆ AIRS-NAM (solid) seems warm biased at most days in lowest levels compared to CNTL-NAM (dashed) throughout forecast cycle

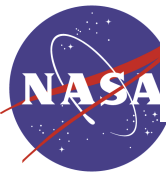
◆ Dudhia SW Radiation Scheme in WRF model used for this experiment

- Case et al. (2007) showed Dudhia scheme exhibits a slight daytime cold bias
- Negative forecast in day
- Positive forecast at night

◆ Changes in lower-level temperature result in changes to geopotential height field in model, which impacts the forecast

1000 hPa Temperature Difference Time Series





Evolution of Analysis Grid

- ◆ Originally grid had 37 levels with high resolution near surface and lower resolution aloft

- ◆ Interpolation of NAM initial conditions to WRF led to the background field being 2-3°C too warm

- ◆ Interpolation error leads to exaggerated innovations at 100 mb that cause either:

- Large changes to the surface pressure field due to correlations in the B matrix or

- Large changes to the surface pressure field due to analysis balance that leads to warming in the other levels to compensate for the large cold change aloft

Model/Ob Soundings near Key West 1/17/07

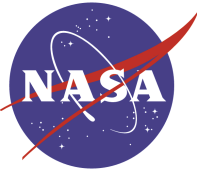
37 Sigma Levels

50 Sigma Levels

NAM ICs

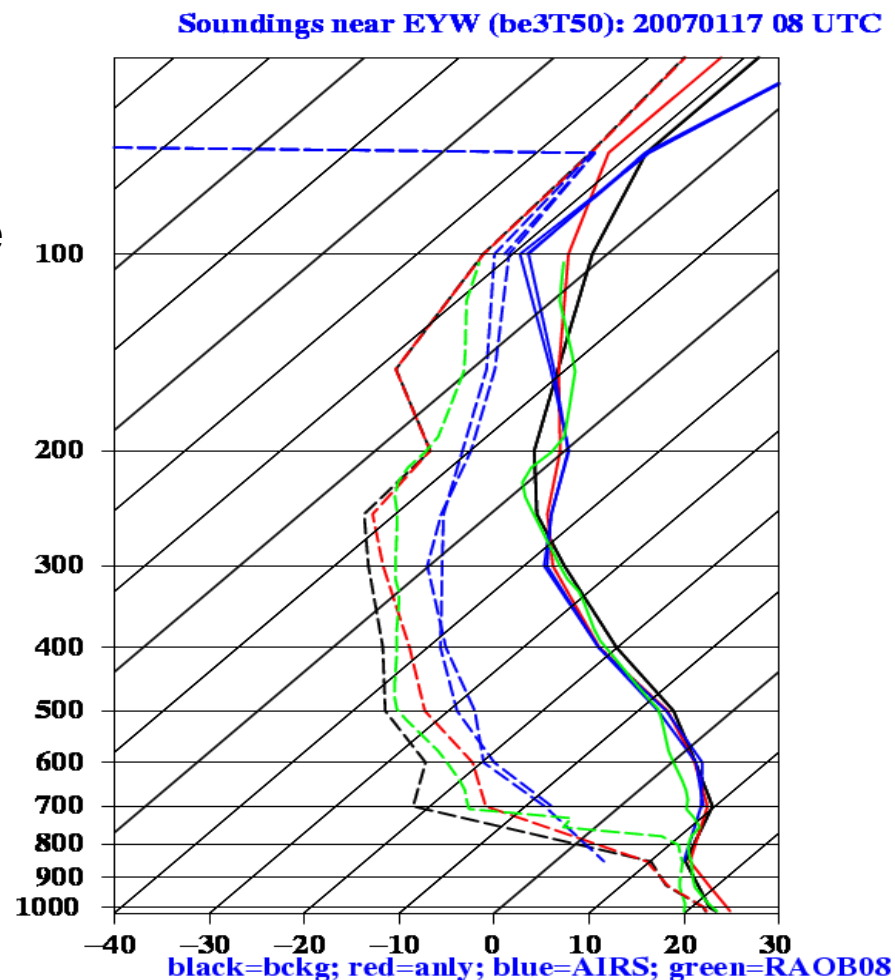
WRF BKGD

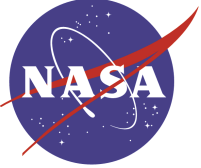
RAOB



AIRS Profiles Too Cold Near Tropopause

- ◆ Observation errors may have been too aggressive
- ◆ We were trying to see what role a large impact from AIRS profiles would have that we underestimated the lower and upper level errors
 - ◆ Thus, best part of profile (mid-troposphere) is corrupted by problems in upper and lower levels of profiles





Conclusion



transitioning unique NASA data and research technologies to the NWS



Questions?
Suggestions?
Comments?

